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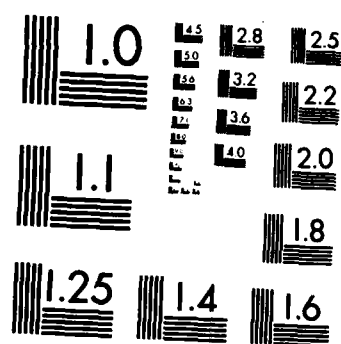
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<p>Electronic Map Data (EMD) is a generic term describing raster format databases created by scanning hardcopy maps or charts. EMD offers great potential as an interim solution for users requiring a digital "picture" of the current paper products. It is more flexible than video disc image databases and can be generated quickly in significantly greater quantities than attributed vector databases.</p> <p>The U.S. Army will be a major consumer of EMD products as a source of geographic data prior to the production of Tactical Terrain Data (TTD) in the mid-1990's. This paper describes the origins of the Army's EMD product requirement as well as the current initiative to define and articulate that requirement to the Defense Mapping Agency (DMA).</p>				
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THE U.S. ARMY ELECTRONIC MAP DATA INITIATIVE

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ABSTRACT

Electronic Map Data (EMD) is a generic term describing raster format databases created by scanning hardcopy maps or charts. EMD offers great potential as an interim solution for users requiring a digital "picture" of the current paper products. It is more flexible than video disc image databases and can be generated quickly in significantly greater quantities than attributed vector databases.

The U.S. Army will be a major consumer of EMD products as a source of geographic data prior to the production of Tactical Terrain Data (TTD) in the mid-1990's. This paper describes the origins of the Army's EMD product requirement as well as the current initiative to define and articulate that requirement to the Defense Mapping Agency (DMA).

INTRODUCTION

Electronic Map Data (EMD) is a new digital product which consists of a raster format database created by scanning hardcopy maps or charts. EMD fulfills the needs of users wishing to transfer the information content of paper products to a digital environment. It offers significant advantages over the current analog video disk products, particularly in the areas of image manipulation and database maintenance. It is less flexible than vector databases because users are unable to access individual features and their associated attributes. Instead, EMD is simply a "picture" of the paper map, with grid cell information recording either the color of the paper product or classes of map features collected from color or feature separates. To create an EMD product, paper products or separates are scanned and geographically referenced. This facilitates rapid population of the database and capitalizes on the significant investment in existing paper products.



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The U.S. Army believes that EMD will become a widely used product in the late 1980's and early 1990's. The remainder of this paper examines how the Army came to recognize the need for EMD and the Army's current program to articulate EMD requirements to DMA.

ORIGINS OF THE ARMY ELECTRONIC MAP DATA (EMD) INITIATIVE

The U.S. Army's recent recognition of a need for Electronic Map Data (EMD) is the result of three factors: first, an awareness of advances in computer technology and applications; second, an increased effort by Army to define digital terrain data requirements; and third, DMA's efforts to develop an EMD product for the Marine Corps AV-8B (Harrier).

Advances in Computer Technology. A number of recent breakthroughs in computer technology have made the development of EMD feasible on a large scale. Key elements in this transition are the availability of relatively low cost scanners capable of imaging large format maps, improved graphic displays, and inexpensive mass storage devices.

Scanning map-size products previously required a drum or flatbed scanner costing several hundred thousand dollars. With the development of Charge Coupled Device (CCD) scanners, it is now possible to purchase a large format scanning device for less than fifty thousand dollars. The availability of a less expensive data capture device has spurred private industry research on applications using EMD as well as low cost techniques for scanning paper maps.

Advances in the exploitation of raster data in the computer environment have been equally, if not more, important than the development of low cost collection devices. Special graphics boards with additional memory can be added to personal computers to provide the power necessary to store and display color images, as well as allow for rapid pan and zoom. Mass storage devices in the form of optical disks (CD-ROM and CD-WORM) now allow the storage of around 500-600 megabytes of information, compared with the 360 kilobytes of information that can be stored on a 5.25" floppy disk. This extra storage is essential because a typical uncompressed EMD database for a 1:50,000 scale map requires tens of megabytes for storage. The large number

of floppy disks required to hold this volume of data would be unwieldy in an operational environment.

The combination of advances in scanning devices, graphics boards and special memory devices means that EMD databases are accessible to personal computers and new applications are possible. Army digital mapping, charting, and geodesy (MC&G) data requirements reflect an awareness of the changing technology and its potential impact on users.

Definition of Army Requirements. The U.S. Army has conducted a series of requirements analyses for Digital Terrain Data (DTD). DTD includes any existing or future digital product which describes the features or elevation of the earth's surface.

A comprehensive Army study, titled "Army Digital Topographic Data Requirements," conducted by the U.S. Army Engineer Topographic Laboratories (USAETL) in 1984, resulted in the definition of a requirement which evolved into the Tactical Terrain Data (TTD) product. TTD is a general purpose database for land combat. It includes attributed centerline information at a 1:50,000 scale with a collection of features selected from the Tactical Terrain Analysis Data Base, the Topographic Line Map, and the Combat Chart, special features not currently found in any DMA product specification, as well as Level 2 Digital Terrain Elevation Data. The Services are currently negotiating the specification for TTD with DMA. If TTD is accepted as a standard product, the first TTD cell will be produced in 1992 as part of the DMA Mark 90 production upgrade.

In 1986-87, USAETL performed an update of the 1984 study. The "Army Tactical Digital Terrain Data Requirements Forecast - (FY87-FY93)" was limited to near-term DTD requirements of fielded systems. Fourteen systems were identified which required some form of digital data, either existing products such as Digital Terrain Elevation Data (DTED) or proposed products like Tactical Terrain Data (TTD). Surprisingly, thirteen of the fourteen systems

* The thirteen systems requiring EMD include the following: Advanced Field Artillery Tactical Data System; All-Source Analysis System/Digital Topographic Support System; Communications System Control Element; Elevated Target Acquisition System; Forward Area Air Defense Command, Control, and Intelligence System; Fiber Optic

required an electronic map display - a digital "picture" of the paper map product. A map display could be generated from TTD, but TTD production is not scheduled until the early 1990's. Clearly a new, easily collected product would be needed in the near-term. EMD provides the solution.

Defense Mapping Agency (DMA) AV-8B Electronic Map Data Developments. While the Army was updating its DTD requirements study, DMA was investigating the development of a new EMD product for the Marine Corps AV-8B (Harrier). In January 1986, Assistant Secretary of Defense for Command, Control, and Communications Donald Latham directed DMA to develop a digital product to replace the film strip product used for moving map displays. DMA had validated the requirement for the AV-8B product and began developing a product specification.

DMA sponsored an Electronic Map Display Working Group Meeting in St. Louis to discuss the proposed product specification for the AV-8B on 25-26 June 1987. The meeting was open to Government and industry representatives. DMA presented a "strawman" for their EMD product. They recommended a raster database in which each grid cell would contain the amount of red, green, and blue (RGB) color of the printed paper map. The information would be stored in twenty-four bits (eight bits red, eight bits green, and eight bits blue) with no compression. Each grid cell would have a resolution of 100 microns (approximately 250 lines per inch). The data would be formatted in a tessellated sphere known as the Equal Arc-Second Raster Chart System (ARC). DMA's proposal was subject to revision and modification with the development of a formal product specification.

THE U.S. ARMY ELECTRONIC MAP DATA (EMD) INITIATIVE

The Army responded to changes in computer technology, increasingly detailed definition of generic Army digital terrain data requirements, and DMA's posture for producing

Guided Missile; Joint Surveillance Target Attack Radar System; Maneuver Control System; Mobile Subscriber Equipment; Patriot Missile System; Position Location Reporting System/Joint Tactical Information Distribution System Hybrid; Remotely Monitored Battlefield Sensor System; and the Tactical Radar Correlator.

an EMD product by embarking on an aggressive Electronic Map Data Initiative in April 1987. The purpose of the initiative was to define the Army EMD requirement and articulate that requirement to DMA.

A timely response to DMA was and is essential so that EMD product specifications developed by DMA can be used by all the Services. Three tasks were identified as being essential for providing input to the Army requirement: first, a survey of commercial activity; second, detailed visits to Army users; and third, the drafting of a consolidated Army EMD requirement.

Vendor Survey. The purpose of the vendor survey was twofold: first, to gain additional expertise in the area of private sector EMD research and development; and second, to compare private sector experiences with the proposed DMA product specification for the AV-8B.

The absence of a public sector EMD product has led industry researchers to develop in-house data generation capabilities. Typically, vendors have acquired CCD cameras to scan images and record the RGB data. Vendors have examined the problems of data capture, color space reduction, spatial compaction, geographic referencing, and databasing.

Within the private sector, there also exists a pool of expertise dealing with EMD applications. There has been a significant amount of research in the aviation community with respect to replacing the current filmstrip charts with digital maps for in-cockpit displays and simulations. This work has been paralleled for ground-based vehicles. Within the intelligence community, efforts have been initiated to substitute digital products for the current video disk products. This varied research is applicable to Army applications in the five battlefield functional elements: Maneuver Control, Fire Support, Air Defense, Intelligence and Electronic Warfare, and Combat Service Support.

A comparison of the proposed DMA product with vendor experiences yields both similarities and differences. Most of the surveyed vendors started with a 24 bit/pixel RGB product similar to the one proposed by DMA. However, all vendors applied color and/or spatial compression to reduce the size of the data set prior to using the data in an application. Several vendors worked with a color separate product, either starting from the color separate data or deriving separates from the RGB image. Users of separates

enthusiastically endorsed the advantages in flexibility of separates versus an RGB image. DMA has proposed a scanning resolution of 100 microns. This resolution is comparable to the resolution vendors typically used to capture data, but most vendors stored the information at about half that resolution before distributing the data to users. The results of this survey indicated that the proposed DMA product is comparable to the initial scan data captured by vendors, but does not represent the data reduction or flexibility found in the typical data set delivered to users.

User Visits. Visits to Army users have paralleled the vendor survey. The main thrusts of the user visits have been the exposure of users to EMD concepts and the development of an understanding of Army system specific requirements. A basic knowledge of the EMD alternatives is necessary for articulating requirements. It has been extremely difficult to separate requirements definition from product specification, just as it has been difficult to separate product specification from current technological capabilities. However, the purpose of the user survey has been to establish the Army requirement and not the DMA product specification.

Development of a Consolidated Army EMD Requirement. Based on the results of the user visits, the Army will develop a consolidated requirement to present to the DMA. The executive agent for this action is the Office of the Deputy Chief of Staff for Intelligence (ODCSINT). The Concepts and Analysis Division of the U.S. Army Engineer Topographic Laboratories is providing technical support to ODCSINT.

The process of defining the Army's consolidated requirement is characterized by three phases: first, the notification of DMA of Army's forthcoming consolidated requirement; second, the solicitation of requirements letters from individual Army users; and third, the drafting of a consolidated requirement.

When the Electronic Map Display Working Group Meeting was held on 25-26 June 1987, DMA had only validated an EMD requirement for one system - the AV-8B. Army's notifying DMA of the Army EMD requirement thus became a high priority objective. On 5 August 1987, General Stanley Hyman, Brigadier General, U.S. Army, and Assistant Deputy Chief of Staff for Intelligence, sent a memorandum to the Deputy Director for Research and Engineering at the Defense Mapping Agency. The letter stated Army's need for EMD and

declared Army's intent to develop a consolidated requirement by January 1988. The letter had five major points: first, Army recognizes DMA's responsibility to develop a product specification for the AV-8B; second, Army is currently validating requirements for thirteen systems; third, the DMA-proposed product specification for the AV-8B may not meet all Army EMD requirements; fourth, DoD elements and industry should be permitted to review and comment on any DMA-proposed EMD product specification; and fifth, prototype EMD products will be necessary to conduct an evaluation of a proposed EMD product specification. General Hyman's letter was intended to notify DMA of Army's EMD requirement and initiate DMA validation of the requirement.

In addition to notifying DMA of an Army requirement for EMD, ODCSINT requested that Army Program Managers, TRADOC System Managers, and Combat Developers formally state their requirements. As of 15 September 1987, letters stating a need for EMD had been received from the Maneuver Control System, the Advanced Field Artillery Tactical Data System, the Elevated Target Acquisition System, the Digital Topographic Support System, the Initial Force Level Control System, Firefinder II, the Fire Support Combat Observation Lasing System, and the LHX, Apache, and V-22 aviation systems.

The requirement letters and information collected during user visits will form the basis for developing a consolidated Army requirement. Science Applications International Corporation is under contract to the Concepts and Analysis Division of USAETL to assist in preparing the draft statement of requirement. The draft will be presented to users at a symposium to be held at USAETL on 9-10 November 1987. Comments will be solicited for incorporation in a final coordinated statement of requirement for EMD. The final requirement will be presented to DMA in January 1988.

SUMMARY

Electronic Map Data will be widely used for background map displays in the Army prior to the development of Tactical Terrain Data. The identification of the need for EMD results from a recognition of recent innovations in computer science, Army's increasing efforts to define digital terrain data requirements, and DMA's efforts to develop an EMD specification for the AV-8B. The need for a

consolidated Army statement of requirement to DMA has led to the Electronic Map Data Initiative. The on-going initiative has been composed of three tasks: first, a vendor survey of capabilities and opinions concerning DMA's proposed product; second, a survey of Army users; and third, the drafting of a consolidated Army statement of requirement for EMD. The consolidated Army EMD requirement will be forwarded to DMA in January 1988.

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